

Global Climate Change: Turning the Tide

In the cauldron of questions surrounding global climate change, public policy issues are heating up. At this time next year in Berlin, the developed countries that signed the United Nations Framework Convention on Climate Change in Rio de Janeiro in 1992 will bring to the table their national plans for limiting greenhouse gas emissions.

In preparation for this meeting, the treaty's Intergovernmental Negotiating Committee is hammering out details in a series of preliminary sessions; the most recent one was held in February in Geneva. In the spotlight was the United States Climate Change Action Plan, a \$1.9-billion pledge by the Clinton administration to cut greenhouse gas emissions by voluntary measures. In an abrupt change from the past, the United States is now leading the way. It is time for the framework to be fleshed out.

The public policy questions seem seductively simple: what should be done, who should do it, how much will it cost, and who goes first? But complicating these questions are scientific uncertainties and other wild cards such as not-yet-discovered technologies, local impacts, and a host of human dimensions that broaden the issue

beyond merely climate to global change. Global change encompasses not only climate change, but also ozone depletion, biodiversity, and the interactions of human development with the environment.

The one certainty is that responding to global change will require unprecedented international cooperation. At the framework convention, 36 developed nations pledged to aim at reducing their greenhouse gas emissions to 1990 levels by the year 2000. They also promised to help developing nations reduce their emissions. But are those commitments enough? The United States, among others, thinks not. "Our convention takes us to the end of the decade—we have not yet begun to look beyond that date," the U.S. statement to the Intergovernmental Negotiating Committee said.

Emissions aren't the only debatable point. Because greenhouses gases (carbon dioxide, nitrous oxide, and chlorofluorocarbons) are so persistent in the environment, their concentrations in the atmos-



James Bruce—Equity between developed and developing countries is a major issue.

phere adjust slowly to changes in emissions. "There's also a general objective stated in the convention that the countries of the world agree they will try to limit concentrations—not emissions—of greenhouse gases at a level that will not cause dangerous interference with the climate system," explains Jim Bruce of the Intergovernmental Panel on Climate Change (IPCC). "That means the countries are going to have to reconsider their commitments." The IPCC estimates that an immediate reduction in emissions from human activities of over 60% would be required to stabilize concentrations at today's levels.

The IPCC, founded by the United Nations and the World Meteorological Society in 1988 to clarify the implications of greenhouse gas emissions, played a crucial role in providing technical support for the framework convention. Today its working groups advise the convention. Bruce, a meteorologist from Canada, is co-chair of working group III, which is focusing on social and economic aspects, including policy options.

Equity

Beyond the adequacy of commitments, the larger question facing the convention is equity between the industrial, developed countries, which produce three-fourths of the carbon dioxide produced by fossil fuels, and the less-developed countries, where three-fourths of the world's people live. "The developing countries have very mixed feelings," Bruce says. "Many of them are very worried about climate change because, for a country like Bangladesh, or the small island states, or Egypt, which have low-lying coastal areas, there are potentially severe flood problems. But they recognize that they're not the ones who are causing the problem. They're very much looking to the first steps being taken by the 36 countries."

Bruce continued, "Talk to people on Vanuatu in the southwest Pacific, and the Maldives, the Bahamas. They say, 'Our emissions mean nothing, and yet we're going to be subject to perhaps more severe storms, and sea-level rise is going to cause devastation.' So they feel hopeless in that sense."

Jose Goldemberg, Brazil's former minister of science and technology, offers another perspective. Currently a visiting professor at Princeton's Woodrow Wilson School, Goldemberg is a lead author for IPCC working group III. "There are three types of pollution: the pollution of the

UNDERSTANDING THE TERMS OF GLOBAL CLIMATE CHANGE POLICY

Carbon tax: proposed tax based on the amount of carbon in fossil fuels. Taxes are designed to force industry to develop substitutes and to raise revenue.

CFC tax: tax on chlorofluorocarbons, which are used as refrigerants and contribute to ozone depletion.

Cascade of knowledge: the discovery, integration, dissemination, and application of knowledge concerning the nature and interaction of matter, energy, and living organisms.

Equity: the balance between developed and developing countries of the burden of the production of chemicals that cause global climate change and the effects of this change.

Human dimensions: practices that contribute to or exacerbate global climate change such as population growth and migration, economic productivity, conversion of natural resources, and sustainable development.

Integrated assessments: combined research in the health, engineering, natural, social, behavioral, and economic sciences to assess impacts of global climate change.

Joint implementation: a method for crediting an industrialized country for reducing greenhouse gas emissions in a developing country.

Sustainable development: the simultaneous promotion of economic growth and protection of the environment.

Tradable permits: international pollution allowances that can be bought or sold.

poor, which is very localized pollution, produced by living; a kind of middle-class pollution, which you have in cities due to automobiles and industry and such; and global pollution, to which Brazil is a large contributor because of deforestation in the Amazon," says Goldemberg.

Brazil has made progress in two of the three areas, Goldemberg points out, removing subsidies that encouraged deforestation and gradually switching half the country's 10 million cars to ethanol fuel, produced from sugar cane, which reabsorbs carbon dioxide in the growth cycle. "What has not been progressing," said Goldemberg, "is [relieving] the poverty. The poor have no where to put refuse, no pure water. The removal of poverty is a larger problem than just fighting pollution."

Two-thirds of Brazil's 150 million people are considered poor, and the impact of global warming, especially drought, would worsen their lives. "That's the main thing, because the rich will take care of themselves somehow," Goldemberg says. With wealth comes the ability to adapt. In the face of warmer temperatures, "they will just purchase a few additional air conditioners," Goldemberg says. "Only the rich buy air conditioners."

Brazil's contribution to climate change is a minor fraction of the world total. Said Goldemberg, "In the worst case, it was five percent. That has been cut in half. Brazil is doing its homework. But 97.5 percent comes from the industrialized countries. Brazil can do a limited amount to help the world."

Reducing emissions that represent only a tiny fraction of the whole has led to "a certain amount of inertia," Bruce observes. Canada's emissions, for example, are about 3% of the world total. "If we cut ours by a fairly substantial amount, it means little in world totals," said Bruce. "So most countries are saying, 'Yes, we're prepared to do things, provided we're sure that everybody else is going to do things.' That's one of the most difficult hurdles to overcome, to get everybody working together and nobody feeling they're out on a limb ahead of everybody else. The United States may be the only country in which efforts within the U.S. alone would have significant effect on the world," Bruce notes.

Equity is no less an issue within countries, says Bruce, who also serves as chair of the Canadian Climate Program Board. "If you have, as in the United States and in Canada, states and provinces which are oil and coal producers and

those which are consumers, and you're going to reduce the consumption of fossil fuels, what can you do to soften the blow in producing states? Of course, it's a question also for the oil-producing countries of the world."

Joint Implementation

A second, but no less heated, policy debate for treaty countries involves joint implementation, a method of crediting an industrialized country for reducing emissions in a developing country.

Joint implementation "gets into the whole issue of who claims credit for the reductions, and how that credit should be shared," explains Granville Sewell of the U.S. State Department's Office of Global Change. To that end, the U.S. action plan provides for a pilot program, but details are not worked out. "How do you calculate emissions reductions?" Sewell says. "How should they be incorporated into some national emissions reduction scheme? There is simply no experience in this."

Joint implementation "is very sensitive and controversial," says economist Erik Haites, a Canadian who heads the technical support unit of IPCC working group III. He explains that those in favor of joint implementation believe it will encourage lowest-cost abatement measures to be implemented first, "so you get the lowest overall cost of reaching whatever goal, be it stabilization or a given reduction in emissions." It would also promote technology transfer to developing countries.

On the other hand, environmental groups oppose it, Haites says, "because they believe industrialized countries should clean up their own emissions domestically. Some developing countries also fear that in the future, if they are asked to reduce emissions, they already will have sold their low-cost options."

Warns Goldemberg, "Joint implementation should not be used as an excuse for each country not doing their homework. It is most welcome, above and beyond the obligation set by the climate convention."

Tradable Permits and Carbon Taxes

Another option to limit emissions involves international tradable pollution permits which could be bought and

sold. "The only way you could adopt tradable permits is if developed countries and developing countries have agreed on quotas," which they have not, Goldemberg says. Otherwise, he adds that tradable permits "really would be licensing the industrialized countries to export pollution. I think that will be resisted. The developing countries have the majority in the conference."

Goldemberg, joined by many economists, supports a tax on the amount of carbon in fossil fuels. "It has two effects,"

Goldemberg says. "It sends a powerful message so people will be more careful, so people will have an economic incentive not to pollute as much. The second is that a carbon tax will collect large amounts of money that could be used for a number of mitigative activities, such as forestation, energy efficiency, and others. Carbon taxes do exist in many countries, but they are not used to prevent climate change," Goldemberg continues. "For example, in the

U.S., the proposal of President Clinton of introducing a carbon tax was to reduce the deficit."

Although Sweden, Finland, the Netherlands, and Norway have carbon taxes, says Haites, track records are lacking. "I don't think any country yet has really been going after the greenhouse emissions for any period of time, so it's hard to say whether any of these policies has been effective." Moreover, developing countries may have no infrastructure to collect carbon taxes or to enforce regulations. Ultimately, Haites notes, internal equity issues, such as what cuts will come from the transportation or energy sectors, will shape policy instruments. Aside from mitigation policies, other debates surround impacts and adaptation, among the greatest unknowns in the climate change arena.

Integrated Assessments and Human Impacts

The primary international initiative by the United States is a \$25-million, two-year Climate Change Country Study. Coordinated by the U.S. State Department, the study is helping some 20-40 countries look at potential impacts of global climate change. The United Nations Environmental Programme, the Asian Development Bank, and Canada and other countries are also sponsoring such studies.

No country-by-country assessment of climate change exists, explains Sewell. "You have to start somewhere. We can get the baseline data. We can help look at



Erik Haites—Joint implementation is controversial.

IPCC



José Goldemberg—The elimination of poverty is a larger problem than fighting pollution.

Princeton U.

CLIMATE ECONOMICS

Although one of the most compelling forces behind the debate on global climate change is economics, many economists are now saying the focus should not be on whether or not to do something, but when.

When American economist William Cline considered the effects of greenhouse warming over a span of 300 years, he found that limiting warming by cutting back on fossil fuel emissions was worth the economic costs. A senior fellow at the Institute for International Economics in Washington, DC, Cline is among the IPCC working group III authors considering economic issues and is the author of *The Economics of Global Warming*.

Among the damages Cline's assessment considered were losses to agriculture and rises in sea level, water scarcity, need for increased electricity for air conditioning, air pollution, incidence of death from heat waves, a die-off of forested areas, and the probable loss of species. With a 2.5°C rise in temperature, Cline estimates a loss of 2% of the gross national product.

Over time, however, Cline found that the figure increases exponentially. "You have to look over a span of three centuries, because that's how much coal we have. The oil and gas would be gone before then," he explains. Global temperatures in 300 years could be as much as 10°C above today's temperatures. "I'm not advocating extreme immediate action, but I do advocate beginning to take action," said Cline. "Many people have said we shouldn't do anything at all until we have more information."

While Cline has looked at avoiding damages, economist Richard Richels, also a working group III author, has focused on the energy sector's price tag for limiting carbon emissions. Richels, coauthor of *Buying Greenhouse Insurance* with Alan Manne, is director of the Energy Analysis and Planning Department at the Electric Power Institute in Palo Alto, California, the research and development arm of the U.S. electric utilities.

The model Richels and Manne developed calculates the cost of a carbon tax to the economy and resulting reduction in emissions. The model also assesses the size of the tax needed to keep emissions at a given level.

Richels found that the price tag to limit emissions starts off relatively small and tends to grow over time because a growing economy produces more carbon. "Right now, we're at 354 parts per million of CO₂ in the atmosphere. If you want to keep it at that level, you're going to have to reduce emissions by something like 60 percent below current levels. If, on the other hand, you pick a target that's about 500 parts per million, then you actually have some room for growth in emissions in the near term and you can still level off concentrations at that level." He notes that the carbon-intensive U.S. energy sector currently has a huge investment in existing capital equipment.

Whatever policy is set has to allow for learning and mid-course correction. The key point is, we don't have to make decisions today for the next hundred years, said Richels. "The real issue is what is the optimal hedging strategy from a societal perspective. It's not just one alternative, it's a portfolio of alternatives."

Comparing such varying models as those of Cline and Richels takes even more sophisticated modeling, such as that conducted at Stanford's Energy Modeling Forum. The forum recently compared 14 models for 13 standardized scenarios to study the cost of controlling emissions and policy options.

Among its findings was that a phase-in program of stabilizing emissions over 40–50 years could cost the developed countries perhaps 1% of gross national product, largely because existing equipment could be used up while research and development produces alternatives.

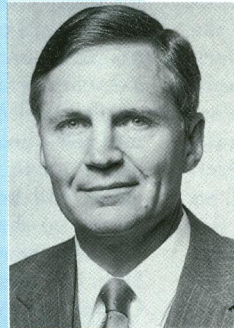
"I think our group would argue that you ought to set some kind of economic incentive," says economist John Weyant, director of the forum and an author for IPCC working group III. Weyant's group prefers the carbon tax because it leaves the means for achieving reductions up to individual decision makers.

As Weyant sees it, U.S. industries have been slow to incorporate efficiency strategies because energy represents a relatively small part of their budgets. The U.S. Climate Change Action Plan, though, attempts to accelerate innovation and efficiencies.

"The question is," says Weyant, "what happens if the action plan doesn't get you to stabilized emissions? There is some fear there will be massive command and control type things."

Despite whatever gains the United States makes domestically, "another key result you get from all these analyses is that you can start the process with the developed countries, but it doesn't get you very far," says Weyant. Widely quoted is the example of China, where coal consumption is expanding. If China's emissions grow by 4% per year, it is estimated that by 2050, they will equal today's total world emissions.

On the agenda at the Energy Modeling Forum is an integrated assessment study that would include some of these models, balancing costs and benefits under uncertainty. "This time we're trying to get the physical scientists actively involved," Weyant explains. "If you do this kind of integrated assessment modeling, you can calculate the value of gaining more information about a particular physical phenomenon."



William R. Cline—It's time to begin to take action.

Institute for International Economics

basic policies. In terms of coastal zone management, for example, there are things that can be done now that will help in the future."

Another example of impacts assessment is the three-year study of the effects of climate change on the world food supply by agronomist Cynthia Rosenzweig, one of the IPCC working group II authors.

Rosenzweig worked with experts from 25 countries including atmospheric scientists, agronomists, economists, and food trade specialists, the latter "because supply and demand adjusts to what happens in farmer's fields." Rosenzweig concluded that people in impoverished countries may face more starvation and malnutrition.

Rosenzweig's interdisciplinary approach is indicative of the new trend toward integrated assessments that take into account more and more variables. Because of their ability to include the social aspects of climate change, integrated systems assessments have been given high priority within the U.S. Global Change Research Program, a collaboration of many government agencies.

Integrated assessments are only one facet of the program's new science priorities in Human Dimensions, an \$11-million program that links research in the health sciences, engineering, and natural sciences with the social, behavioral, and economic sciences. "We're trying to understand the human–environmental interface. The primary reason the U.S. government is currently spending in excess of \$1.5 billion for global change research is the recognition that not only do we want to know what is happening in terms of human and natural systems, but we want to have a better understanding of ways in which we as humans can take action," says geographer Thomas Baerwald, coordinator of U.S. Global Change Research Program. "As social scientists," said Baerwald, "we've got plenty of great examples where very well-intended policies weren't properly evaluated in the total context. The result was you ended up with just the opposite of what you wanted."

Human Dimensions

Under the umbrella of human dimensions are critical questions related to patterns of human activity, not only population growth, decline, and migration, but shifts in economic productivity and development. Scientists studying such questions "try to better understand the ways in which people operate in the context of change and transition," Baerwald explains.

He notes that the risk of health-related problems acts as a faster trigger for action than other issues.

Human dimensions also encompass sustainable development, considered by many to be the crux of all global issues. Sustainable development, many experts point out, is the ultimate adaptation to global change.

As world population continues to grow and nations continue to convert natural resources into goods and services, many continue to call for environmentally sound practices and policies. "You don't have to pollute," says Thomas Malone, director of Sigma Xi, a scientific research society. "You have to transform that energy and that technology-driven economic system into systems which are environmentally benign. One of the key points is that we need to have quantitative estimates of the impacts of environmental deterioration, including falling below the threshold of a healthy environment."

Cascade of Knowledge

At an international workshop convened by Sigma Xi last fall, participants called for a large-scale effort to strengthen the cascade of knowledge that drives progress. "This cascade embraces the discovery, integra-

tion, dissemination and application of knowledge concerning the nature and interaction of matter, energy, living organisms and information," says the workshop's recent report. It urges new modes of communication and cooperation, and new patterns of interdisciplinary collaboration. Says the report, "A more intimate interaction among industrial countries and developing countries is imperative." The report proposes a "Global Array of Nested Networks" to integrate such a cascade of knowledge.

"The critical ingredient in helping people around the world make better decisions is knowledge," says workshop participant Bill Robertson, executive vice president for the World Engineering Partnership for Sustainable Development, headquartered outside Washington, DC. "If you only deal with the North and not the South, only the rich and not the poor, only with countries who have their population growth under control and not with



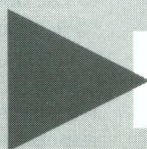
Cynthia Rosenzweig—People in impoverished nations may face some of the worst impacts.

those who are totally out of control, then you'll never deal effectively with the climate change issue," said Robertson. "Right now a lot of the knowledge necessary for people to produce with less waste and less energy and to make sustainable decisions is not shared openly around the world."

"Regarding climate change and sustainable development," said Robertson, "we're trying to get others to understand that if you want to leverage your investment dollar, then you must cause people to learn from each other faster, better, cheaper." Robertson's partnership brings to the forefront another wild card in global change: yet-to-be discovered technologies to aid in both mitigation and adaptation. "It's in the application of technology where we can make a difference right now, in our generation," says Robertson. "The question is how can we engage the engineer to help the policy maker utilize natural resources in a more efficient, sustainable way."

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